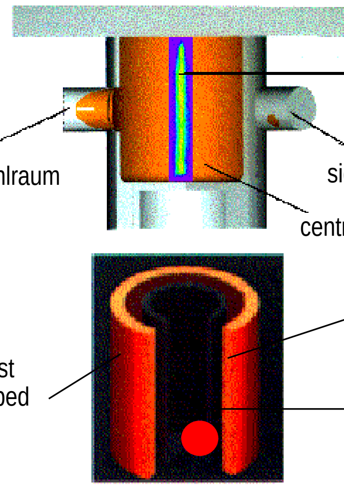
June 1996 Highlights of the Pulsed Power Inertial Confinement Fusion Program



a) Static, vacuum hohlraum, driven by x rays from tungsten wire array, and b) dynamic, imploding hohlraum, driven by x rays from implosion of a cylindical low-density foam.

We gave talks at the 11th International Conference on High Power Particle Beams, the IEEE International Conference on Plasma Science, and the European Conference on Laser Interaction with Matter about experiments and simulations with z-pinch loads and ion beams. Progress has been made in modifying PBFA II to allow z pinch implosions. We are designing z-pinch hohlraum experiments for PBFA Z after power and energy scaling from Saturn to PBFA Z is demonstrated.

We are studying two types of z-pinch-driven hohlraums (see figure). The first (a static, large-volume, vacuum hohlraum) consists of a central 2-cm-diameter, 2-cm-long cylindrical hohlraum that has two smaller hohlraums attached to its sides. The central hohlraum is driven by the implosion of a cylindrical array of wires that produces a plasma radiation source on axis. Soft x rays from the implosion heat the walls of the central cavity, which then reradiate into the side hohlraums. The second (dynamic) hohlraum type is formed by the implosion of a low-density foam z pinch. Here, the energy of the imploding pinch directly heats the hohlraum. The outer region of the foam is doped with gold so a large fraction of the radiation generated is contained within the system. A variant of this system, with the promise of enhanced coupling, implodes a z-pinch wire array onto low density cylindrical foam. Radiation trapped in an imploding (dynamic) hohlraum can produce higher temperatures than a static (nonimploding) hohlraum. Hohlraum temperature is determined via an active shock breakout diagnostic, in the case of a vacuum hohlraum, and with x ray diodes; a transmission grating spectrograph provides detailed information about the thermal radiation spectra.

Z pinches are power amplification devices: electrical energy is fed into the pinch over the electrical pulse time and then extracted in a (shorter) thermalization time. High-energy, high-power x ray environments are generated that are useful for exploring capsule physics relevant to ignition and high yield. On Saturn we have obtained 0.5 MJ in x rays from z-pinch implosions. With modifications to PBFA II to enable z-pinch loads (PBFA Z), we expect to obtain 1.5 - 2 MJ in x rays. If scaling from 85 TW and > 80 eV on Saturn to 150 TW and > 120 eV on PBFA Z is demonstrated in early FY 97, our strategy will then be to design a follow-on advanced plasma radiation source facility, X-1, that delivers ~ 40 MA to a z-pinch load and generates 6 - 8 MJ of x rays. A new pulsed power testbed, the Advanced Pulsed Power Research Module (APPRM), has been constructed by the Test Program and is now operational to validate new pulsed-power component design and system architecture, with possible application to a proposed X-1. The APPRM was constructed with three distinct submodules, each capable of producing 2.5 MV at 2 MA. Full voltage tests began in June, and initial data indicate good agreement with the design modeling.

The near term emphasis in the program is shifting away from light ions and towards z pinches. Basic research into the limits of ion beam focusing will be done on SABRE at Sandia, on Gamble II at NRL, and on the newly completely COBRA at Cornell. New high-magnetic-field banks were delivered this month for the low-power (compared to PBFA X) SABRE facility. The higher insulating magnetic fields possible with these banks can delay the onset of damaging electromagnetic instabilities that are a primary limitation of ion beam focusing. The new banks will also allow evaluation of the use of an electron limiter to collect electrons. Without an electron limiter, electrons can get too close to the anode and contribute to ion beam defocusing (divergence) and to the increase in nonlithium contaminants of the ion beam.

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